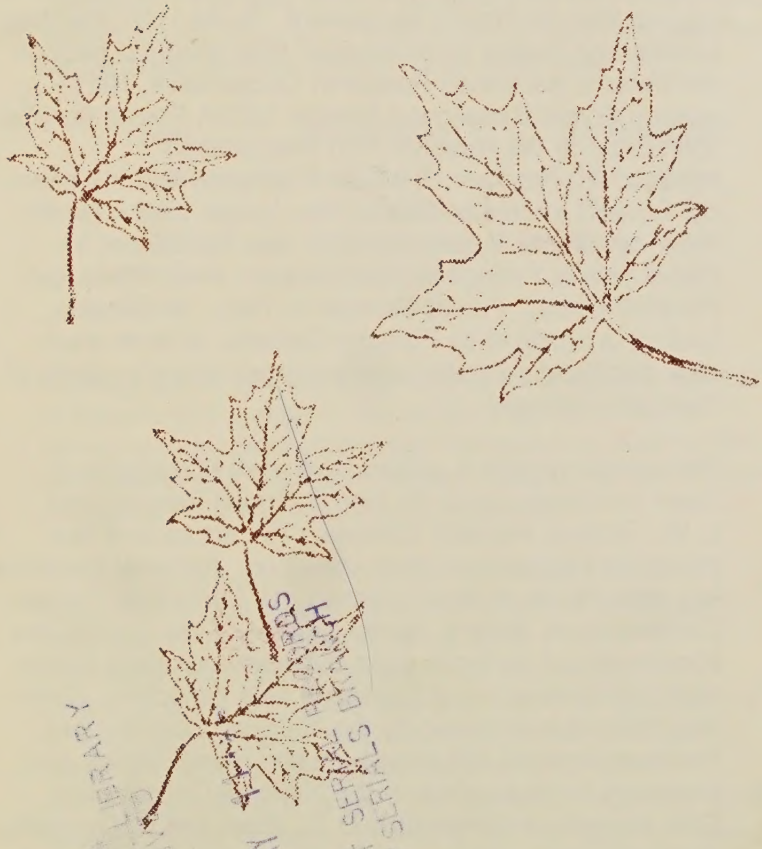
United States
Department of
Agriculture

Forest Service

Northeastern Area
State & Private Forestry

Forestry **Forêts**
Canada Canada

Sugar Maple Crown Conditions Improve Between 1988 and 1992



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INTRODUCTION

During the late 1970's and throughout the 1980's, sugarbush managers and foresters who managed northern hardwood stands became concerned about maple decline. The problem seemed to be most severe in Quebec. A working group of scientists recommended that a special project be designed to monitor and evaluate sugar maple condition, particularly in response to pollution, stand management intensity and other disturbances. The North American Sugar Maple Decline Project (NAMP) was formed in 1987 between Canada and the United States and authorized by a Memorandum Of Understanding and Special Project Agreement. In the U.S., the initial funding and project administration was provided through the Eastern Hardwood Research Cooperative, Northeastern Forest Experiment Station, USDA Forest Service, sponsored by the National Acid Precipitation Assessment Program. The administration and the financial support for this endeavor, now known as the North American Maple Project (NAMP), was transferred to Forest Health Protection, Northeastern Area, State and Private Forestry, Forest Service, in 1991. In Canada, funding is provided by Forestry Canada. In both countries, participating states and provinces share in some of the local expenses.

The current project is guided by a Joint Management Team co-chaired by G. D. Hertel, Forest Service, and L. W. Carlson, Forestry Canada. Ten states and four provinces cooperate in data collection. National Coordinators provide day-to-day guidance: D. Lachance, Forestry Canada, and I. Millers, Forest Service. Data quality and consistency of methods used between regions receives high priority because of the many data collectors. Common training is provided by the National Coordinators. Remeasurements are done between crews, states and provinces for evaluation by the National Coordinators. Data analysis is provided by D. C. Allen and R. Cymbala, State University, College of Environmental Science and Forestry, Syracuse, New York.

OBJECTIVES

The objectives of the project are to determine:

1. the rate of annual change in sugar maple tree condition ratings.

2. if the rate of change in sugar maple tree condition ratings are different among:

   a. various levels of sulfate and nitrate wet deposition.
   b. sugarbush and undisturbed forest.
   c. various levels of initial stand decline conditions.

3. the possible causes of sugar maple decline and the geographical relationships between potential causes and extent of decline.

PLOT ESTABLISHMENT

The total number of plot-clusters has increased from 171 to 219, and three more states (Minnesota, Ohio, and Pennsylvania. have joined the NAMP). The monitoring area now extends from Minnesota and Ontario, south to Ohio and Pennsylvania, and east to Nova Scotia (Fig. 1):

United States		Canada	
Maine	18	New Brunswick	12
Massachusetts	10	Nova Scotia	2
Michigan	18	Ontario	24
Minnesota	8	Quebec	24
New Hampshire	6		
New York	27		
Ohio	6		
Pennsylvania	6		
Vermont	40		
Wisconsin	18		

One-half of the plot-clusters within a state or province are active sugarbushes and one-half are in forest stands that had not experienced deliberate forest management activities for at least 5 years preceding establishment of plot-clusters. Local regions chose the stands at various initial stand decline conditions. The region includes a variety of site conditions and covers most of the prime sugar maple growing areas. In 1988, annual sulfate wet deposition ranged from 9 to 31 lbs/ac (10 to 35 kg/ha), and nitrate wet deposition ranged from about 7 to 13 lbs/ac (8 to 15 kg/ha). Indications are that deposition has remained about the same through 1992, but more detailed analysis will be presented in the 5-year report in 1994.

Each plot-cluster consists of five 66- x 66-ft. (20- x 20-m) plots located in a sugar maple stand 50 to 150 years old. The average sugarbush has approximately 155 trees per acre (383 trees/ha), 77% of which are sugar maple, and the average tree diameter at breast height (d.b.h.) is 10.2 inches (26 cm). The undisturbed stands have about one-fifth more trees than the active sugarbushes, 68% of which are sugar maples, with a slightly smaller average d.b.h. of 9.4 inches (24 cm).

Observations were made on about 18,500 trees, of which approximately 70% or 13,500 are sugar maples. Sixty-eight percent of the live sugar maples are in the dominant or codominant crown positions. The other more common species are American beech, yellow birch, red maple, and ash.

Sugar maple crowns are evaluated annually for dieback, foliage transparency, discoloration, and insect defoliation. The latter requires a minimum of two visits, one to detect early season defoliators and another for defoliators that appear in mid-summer. The incidence of dieback and transparency fluctuates from year to year, probably as a result of individual tree response to changes in weather and site conditions. However, continued monitoring will reveal long-term trends in forest health and possibly disclose the impact of disturbances such as global warming, air pollution, defoliation, drought, or a combination of these.

Quality and consistency of data are assured through annual training and certification of field crews. At least 5% of the crown ratings are repeated by check crews to assess measurement variability. Approximately 90% of remeasurements in 1988 fell within the prescribed standards. This improved to about 95% in 1989 and 1990.

ANALYSIS

Even though, 219 plot-clusters were examined in 1992 and are used to describe the condition of sugar maple, the evaluated change reported below is based on a comparison of sugar maples in 165 plot-clusters only; that is, those established in 1988 and remeasured yearly including 1992. The remaining plot-clusters were established after 1988.

The current health of sugar maples is assessed from these non-randomly selected plot-clusters. However, data from other surveys and our own general observations do not indicate that maples outside of our sample areas are greatly different.

Pollution effects on sugar maple will be presented in the 5-year report in 1994. Cursory examination of the data to date does not suggest any great impacts.

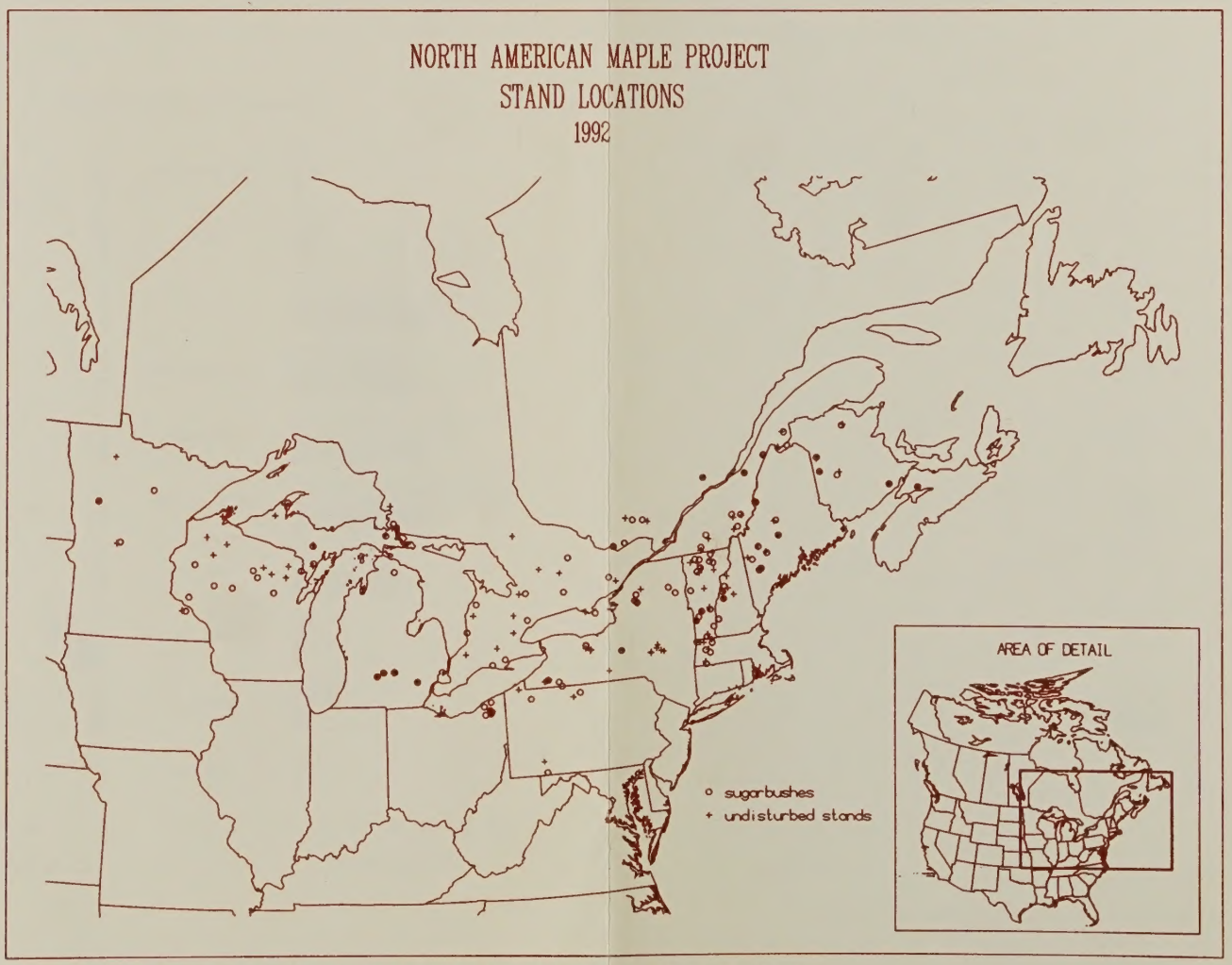


Figure 1.--Distribution of plot-clusters in the North American Maple Project.

The results presented here are based on analyses of crown conditions for about 7,000 upper canopy sugar maples (dominant and codominant trees). Branch dieback in the upper crown is a sympton of stress. For our purposes, up to 5% dieback is considered normal; 6% to 15% percent indicates moderate damage; and more than 15% dieback indicates serious damage. The abundance of foliage, i.e., crown density is another measure of tree vigor. It is measured as transparency; that is, according to the amount of light coming through the foliated portion of a crown. Transparency of 25% or less is considered normal and 26% and more indicates low tree vigor.

Foliage discoloration was rated, but the incidence was low. So, no detailed analyses of these characteristics are presented.

SUGAR MAPLE CONDITIONS IN 1992 AND CHANGES SINCE 1988

Dieback

The average stand dieback of sugar maples in 1992 was 7% in sugarbushes and 5% in non-sugarbushes (Fig. 2). The annual average percentage of stand dieback for sugar maples during the 5-year period was:

Year	Sugarbush	Undisturbed
1988	9 (+/-0.4)	7 (+/-0.4)
1989	8 (+/-0.4)	6 (+/-0.3)
1990	7 (+/-0.4)	6 (+/-0.3)
1991	6 (+/-0.3)	6 (+/-0.3)
1992	7 (+/-0.4)	5 (+/-0.3)

The proportion of upper canopy sugar maples rated with significant crown damage (more than 15% dieback) in 1992 was 6.2% in sugarbushes and 3.8% in undisturbed (Fig. 3). This was a decrease from 10.7% in sugarbushes and the 7.3% in undisturbed stands recorded in 1988.

No biologically significant differences in average percent stand dieback were found in sugarbushes among states and provinces in 1992 (Fig. 2). Wisconsin had the lowest average dieback for sugarbushes and undisturbed (1% and 2%, respectively). At the other end of the spectrum, average dieback in several states was 7% to 9% for both management classes. No major changes in levels of dieback occurred from 1990 to 1992.

Changes in crown dieback rating of 20% or more are considered biologically significant. Between 1988 and 1992, overall, 3% of the trees improved by 20% or more and 2% worsened in sugarbushes. In undisturbed stands, 2% improved and 1% declined by 20% or more. Most of the states and provinces experienced improvement, except New York, Ontario, New Hampshire and Maine, where fewer trees improved than declined by 20% or more (Fig. 4). In New York and Ontario, forest tent caterpillar defoliation contributed to increased dieback and in Ontario severe drought occurred in the late 1980's.

DIEBACK

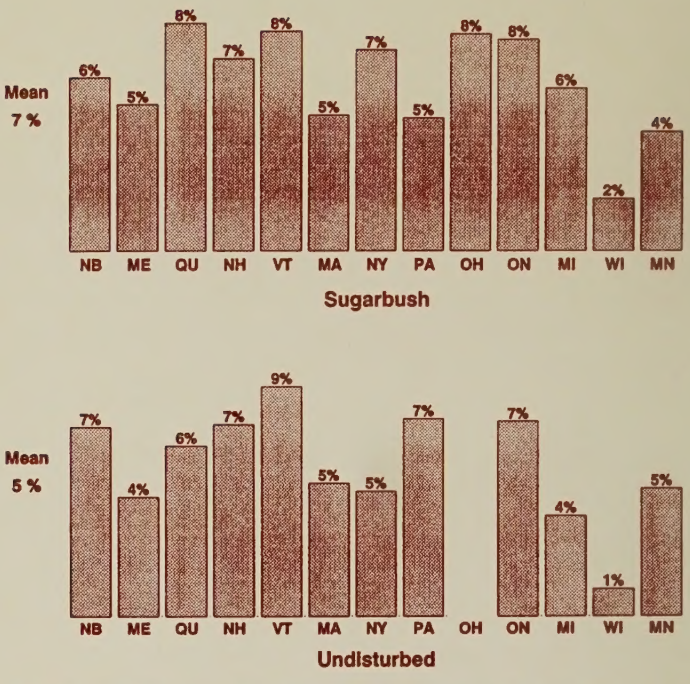


Figure 2.–Average percentage of sugar maple dieback in 1992 in NAMP–by region and stand management class.

Transparency

The average stand transparency for upper canopy sugar maples in 1992 was 14% in sugarbushes and 13% in undisturbed stands (Fig. 5). The annual average transparency percentage between 1988 through 1992 was:

Year	Sugarbush	Undisturbed
1988	18 (+/-0.8)	16 (+/-0.8)
1989	10 (+/-0.6)	19 (+/-0.6)
1990	15 (+/-0.6)	14 (+/-0.5)
1991	12 (+/-0.3)	12 (+/-0.4)
1992	14 (+/-0.4)	13 (+/-0.4)

Average stand transparency in sugarbushes was highest in Ontario and lowest in Wisconsin (Fig. 5). In undisturbed stands, highest average transparency was in New Hampshire, and Michigan had the lowest (Fig. 5). These differences are not meaningful biologically.

In 1988, 21.3% of the upper canopy sugar maples in sugarbushes were rated with more than 25% transparency, but in 1992 this declined to 5.9% (Fig. 6). In undisturbed stands, the percentage decreased from 17.8% to 5.0% during the same period. Transparency of 12% of sugar maples improved by 20% or more from 1988 to 1992 in sugarbushes compared to 10% in undisurbed stands (Fig. 4). Transparency improved in all regions except Ontario. In Maine and Wisconsin, transparency improved during the first 3 years but has increased since 1990. These changes are not biologically significant.

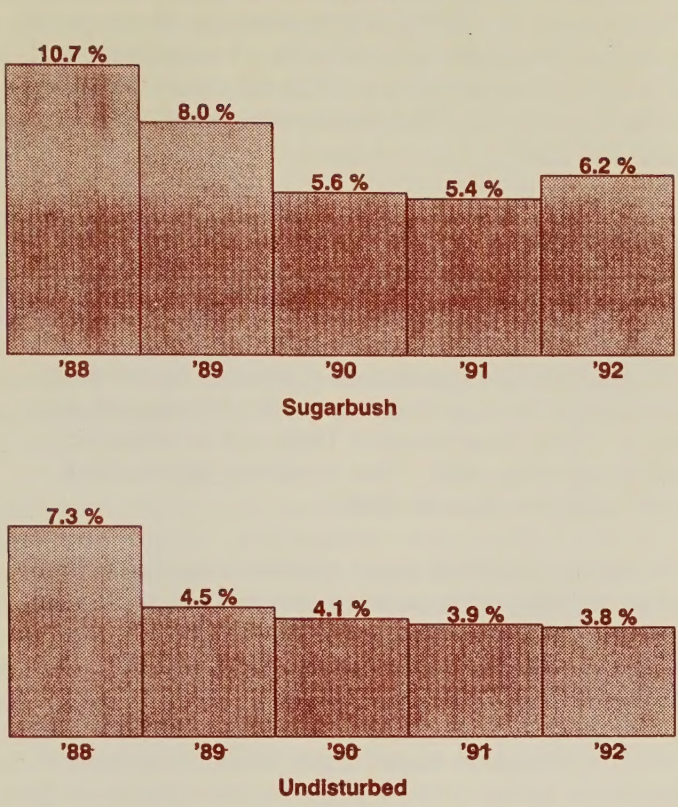


Figure 3.--Annual mean percentage of sugar maples with 16% or more dieback in the NAMP by stand management class.

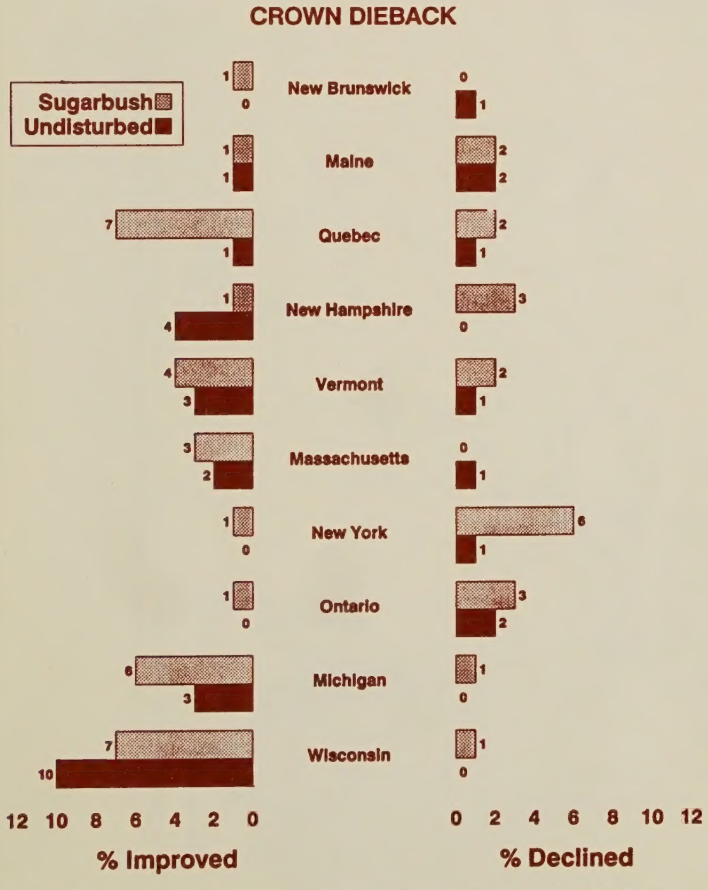


Figure 4.--Percentage of sugar maples rated 20% higher (declined) or lower (improved) for dieback and transparency in 1992 than in 1988 in the NAMP--by region and stand management class.

TRANSPARENCY

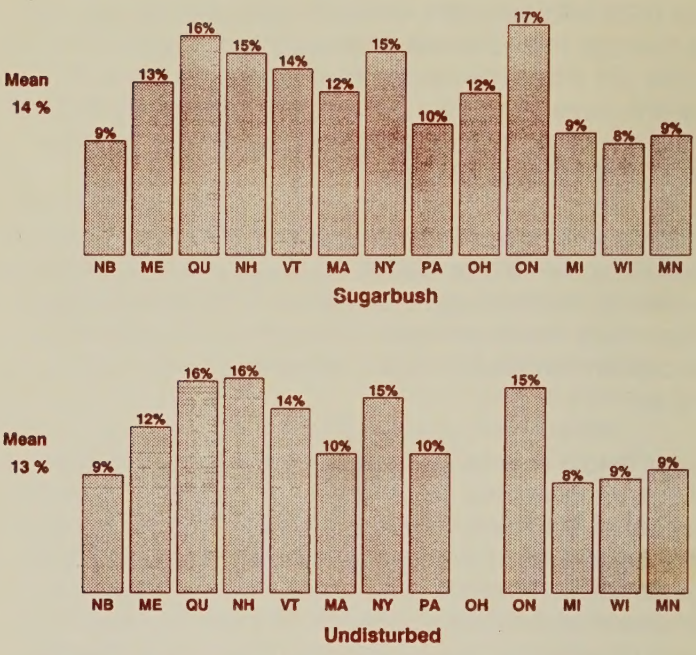
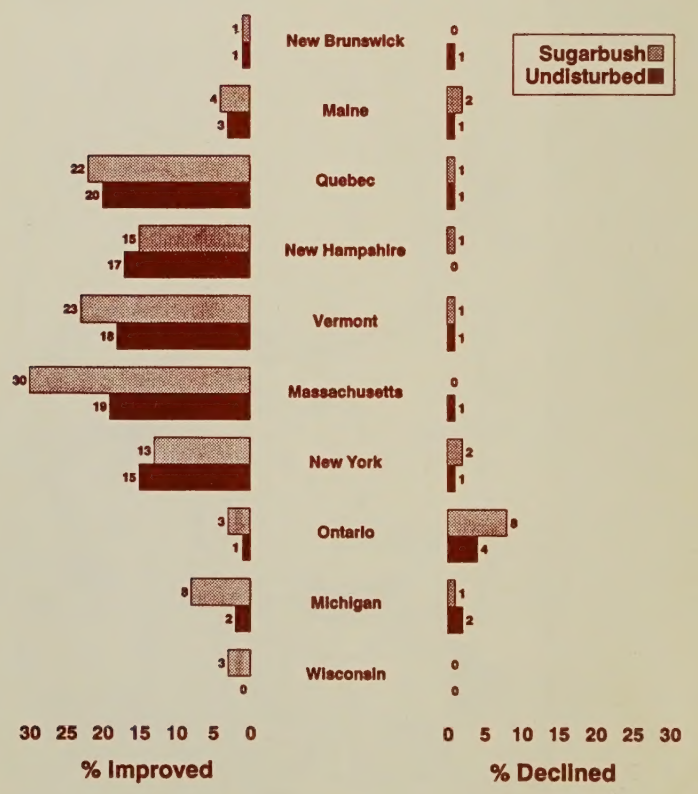


Figure 5.--Average percentage of sugar maple transparency in 1992 in North American Maple Project--region and stand management class.

CROWN TRANSPARENCY



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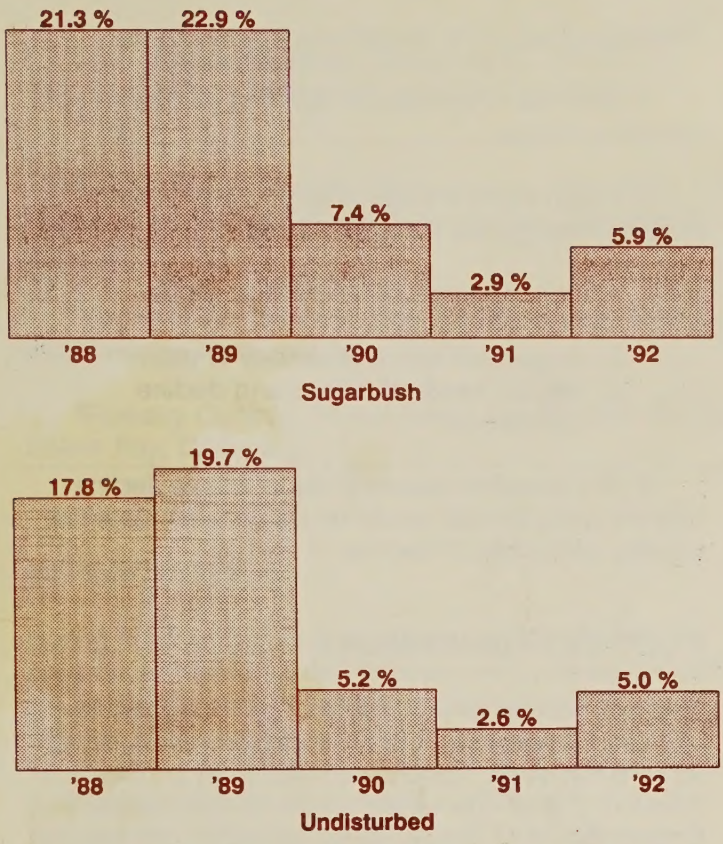

Figure 6.--Annual mean percentage of sugar maples with 26% or greater transparency in the North American Maple Project by stand management class.

DISCUSSION

More than 90% of the sugar maples examined are considered healthy.

The condition of sugar maples in stands managed for sap production was essentially no different from those in undisturbed stands.

Most of the crown condition improvements are associated with decreased damage due to pear thrips in Massachusetts and Vermont, forest tent caterpillar and maple webworm in New York, forest tent caterpillar in northern Ontario and recovery from the severe drought of 1988 in Michigan and Wisconsin.

CONCLUSIONS

The following conclusions are based on the results from the plot-cluster data collected since 1988:

- ❑ Overall the condition of the NAMP plots has improved since 1988.
- ❑ Sugar maple health is similar between sugarbush and undisturbed stands.
- ❑ Insect defoliation and drought adversely affected sugar maple crown condition in some locations.

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